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**From:** G D Beckett [g.d.beckett@aquiver.com]  
**Sent:** 4/15/2019 1:53:13 PM  
**To:** Donald Thomas [dthomas@soest.hawaii.edu]; Grange, Gabrielle Fenix [gabrielle.grange@doh.hawaii.gov]; Ichinotsubo, Lene K [lene.ichinotsubo@doh.hawaii.gov]; Robert.Whittier@doh.hawaii.gov; Shalev, Omer [Shalev.Omer@epa.gov]; TU, LYNDESEY [Tu.Lyndsey@epa.gov]; Matt Tonkin [matt@sspa.com]  
**Subject:** Re: 30X dilution at the Red Hill Shaft

Thanks for the thoughts Bob!

A couple quick followup returns. There are two key aspects of the dilution potential, one is what is induced by production pumping and the wider distribution of accelerated in-flows into the shaft. The other is the proportion of the hydrostratigraphic units connected to the tank farm plume(s) vs. the remainder. As you note, we'd expect the first case (RH pumping) to cause the greatest dilution. However, the second question is more difficult to answer but I'll suggest this: at the distance of the RH shaft production zone, even if within a singular HSU, there should be a very large dilution factor because the "source" zone is expected to be relatively thin vs. the thickness of the HSU and the volume of water moving through it.

Second, as you noted at RHMW05, *"TPH values for the bailed samples was generally more than an order of magnitude greater than subsequent samples"* These two issues both relate to the LNAPL source term character and its dilution, both at RH shaft and also MW locations. This is a perfect example of why we have suggested that the Navy do vertical profile sampling on the existing MWs. Given what you've noted and all the other issues related to our response letter, this potential sampling seems all the more useful. As we've discussed, it's quite inexpensive, easy to accomplish and will likely better inform risk/transport modeling by assisting with a more detailed interpretation of the source/dissolved phase behavior and inter-relationships.

I recommend that we ask the Navy to do that vertical profile sampling for petroleum-related analytes, TEAs, temp & conductivity. It makes use of existing sampling locations, can be done quickly, and is a low-cost event with potential high value interpretive returns. While we have no way of knowing ahead of such sampling, it potentially may more certainly address the actual plume distribution that we've been considering for so long.

Best regards

**G.D. Beckett, RG, CHg**

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>>> Whittier, Robert<Robert.Whittier@doh.hawaii.gov> 4/15/2019 1:28 AM >>>

Hi All,

After the webEx I got to thinking about 30X dilution at the Red Hill Shaft and whether or not this reduces our confidence in the petroleum compound detections at the Red Hill Shaft. The conundrum is why are we getting petroleum related compound hits at the Red Hill Shaft (RHMW2254-01) when there is so much dilution. A 30 times dilution has been estimated.

Matt, I think I may have steered you wrong. When the Red Hill Shaft is pumping there is a large volume of flow into the infiltration gallery, primarily into the southeast end. However, I think it needs to be considered that the dilution during sampling is much less than the bulk dilution value when the Red Hill Shaft production pumps are in operation. The environmental samples are collected from a low flow sampling pump at the west end of the infiltration gallery. When RHMW2254-01 is sampled, the production pumps are shut off. With the production pumps off there seems to be some stratification of the groundwater as indicated by the temperature gradient at RHMW05 (the monitoring well nearest the infiltration gallery).

RHMW05 was sampled with a bailer for the first four events until a down hole pump was installed. The bailer sampling was done to capture water as near to the top of the water table as possible. The TPH values for the bailed samples was generally more than an order of magnitude greater than subsequent samples collected from deeper in the well screen with a downhole pump. A similar condition may exist at the Red Hill Shaft. If the water captured by the RHMW2254-01 sampling pump is lateral flow into the infiltration gallery rather than deeper water drawn up by the production pump, the dilution effect would be much decreased, increasing the probability of petroleum product detections.

The take home point is that assigning the bulk dilution value estimated for Red Hill production pumping is not reflective of the conditions when the environmental sample is collected. So the detections at RHMW2254-01 really do not present the conundrum that at first glance it would appear.

Thanks,  
Bob W